IMPERIAL BUREAU
21 SEPT 1927
OF MYCOLOGY

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1527

PEACH BROWN ROT & SCAB

BROWN ROT AND SCAB, diseases of the peach caused by two different species of fungi, annually cause heavy losses in practically all sections of the eastern half of the United States in which peaches are grown. Fruit, twigs, and leaves may be affected by these diseases, but the chief injury is to the fruit. The fungi causing scab and brown rot are able to penetrate the unbroken epidermis of the fruits, but the fungus causing brown rot enters more readily through wounds, and particularly through punctures made by the curculio or peach worm.

Brown rot, scab, and curculio can be controlled by spraying or dusting. Directions for the application of sprays and dusts, together with formulas and methods for making up the various spray fluids and dusts, are given in this bulletin. Removal of sources of infection is useful as a supplemental measure in the control of brown rot.

Washington, D. C. Issued April, 1927

PEACH BROWN ROT AND SCAB

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DISTRIBUTION AND ECONOMIC IMPORTANCE

BROWN ROT[1] (the common rot of the peach) and scab[2] or "black spot" are linked together in this bulletin because they have somewhat the same distribution and because both are controlled by spraying or dusting during the growing season. Probably both diseases occur to some extent wherever the peach is grown.

In the United States these diseases are of particular importance in the eastern half of the country, in the more humid sections of which they cause large losses nearly every year. Because they are favored by nearly the same conditions, they are usually found together, but in certain sections one may be more serious than the other. For example, in central Georgia brown rot is much more destructive than scab, whereas in parts of the Appalachian highland scab is regularly the more destructive. Brown rot has frequently caused practically complete loss of the crop over entire sections devoted to the growing of peaches, while scab seldom causes such loss even in individual orchards. Brown rot develops rapidly, often taking the grower unawares, and is not only an orchard disease but is also the most common cause of losses in transit and on the market. Scab develops slowly, and new infections on the harvested fruit are not important.

Figures compiled by the plant disease survey of the United States Department of Agriculture indicate that in the years 1918 to 1924, inclusive, the annual losses from brown rot averaged about 3,500,000 bushels, while losses from scab for the years 1922 to 1924, inclusive, averaged somewhat more than 1,000,000 bushels annually. Previous to 1910, before spraying for the control of brown rot and scab became a general practice, the annual losses were proportionately greater than in later years.

[1] Caused by the fungus *Sclerotinia fructicola* (Winter) Rehm.
[2] Caused by the fungus *Cladosporium carpophilum* Thüm.

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BROWN ROT

The disease generally known as brown rot or monilia rot is the common rot of peaches, plums, or other stone fruits and is well known to both growers and consumers of peaches. It is caused by the fungus *Sclerotinia fructicola* (Winter) Rehm, also commonly called *Sclerotinia cinerea* (Bon.) Schröt. Brown rot is not a common rot of apples, pears, or other pome fruits in the United States. The same or a very similar disease probably occurs in all parts of the world in which the peach is grown.

The name, brown rot, describes the disease as it occurs on the fruit of the peach. (Fig. 1.) It is first visible as a tiny brown speck, which develops rapidly and penetrates deeply into the flesh. The whole peach may be involved and finally may shrink into a hard, brown "mummy." (Fig. 2.) After the rot has attained some size, and especially after the whole fruit is involved, masses of spores (conidia) are produced on the surface of the rot. (Figs. 1 and 2.) These grayish masses, easily discernible to the naked eye, on drying break up to form the fine dust which one finds on his hands after handling rotten peaches.

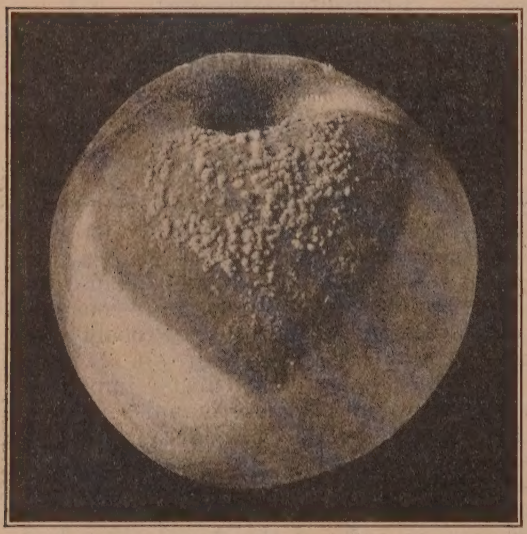

FIG. 1.—Brown rot of peach showing masses of spores (conidia)

If the "mummied" fruits are left on the tree the fungus may grow through the stem of the peach and into the twig, causing a canker or killing the twig by girdling it.

The fungus causing the brown rot of the fruit may also cause a disease of the blossoms. In this phase of the disease, commonly known as blossom blight, the infected blossoms quickly turn brown and die. The dead blossoms adhere to the twig, frequently throughout the season. (Fig. 3.) The disease often progresses from the blossoms into the adjacent leaves, causing them to turn brown and die; also into the twigs, causing small cankers or killing the twigs by girdling them. (Fig. 3.) On the surfaces of the dead parts gray masses of spores (conidia) are soon produced in great abundance. Except in a few restricted districts where the weather at blossoming time is regularly very humid, blossom blight does not usually cause much direct loss. It is of importance, however, because the spores produced on the blighted blossoms and the accompanying cankers may serve as sources of infection for the ripening fruit.

Brown rot sometimes occurs on leaves adjacent to diseased blossoms and fruits. It may also occur on leaves which have been injured by other agencies. As a disease of the foliage, however, it is not important.

The fungus causing brown rot may pass the winter in the mummied fruits hanging on the trees or lying on the ground. On these, during the following season, spores (conidia) may be formed, which carry the disease to the blossoms, twigs, and fruits of that season. In addition to producing the spores (conidia) commonly found, the mummies on the ground—particularly the half-buried ones—often produce goblet-shaped fruiting bodies (apothecia) which shoot into the air another kind of spores (ascospores). (Figs. 4 and 5.) The goblet-shaped fruiting bodies grow out from horny coverings (sclerotia) with which the fungus invests the mummies, and the period of their production corresponds very closely with the blossoming period of the trees. Mummies of any age may produce these fruiting bodies, but most of them are from mummies 1 and 2 years old. From these fruiting bodies spores are shot out in quantities so large that the mass resembles a cloud of dust. It is believed that most of the blossom infections are caused by these spores. Spores of the other sort are also capable of causing blossom blight, but they seem not to be present at blossoming time in such large numbers as are those produced by the goblet-shaped fruiting bodies.

FIG. 2.—Mummied fruits producing spores (conidia) of the brown-rot fungus

The spores (conidia) formed on the blighted blossoms and on the ensuing twig cankers serve to carry the disease along to the ripening fruit. When there are many blighted blossoms it is certain that there will be an abundance of spores scattered about to infect the fruit if conditions are otherwise favorable. In like manner the rotted fruits of early varieties of the peach, many of which are worthless even when producing sound fruit, and the rotted fruits of neglected and usually worthless seedlings help to carry the disease along to fruits of more valuable varieties.

The fungus causing brown rot is able to penetrate the unbroken skin of the peach, but when weather conditions are not especially

favorable to the disease it more commonly enters through wounds and particularly through the punctures made by the plum curculio or peach worm. Control of the curculio is, therefore, an important step in the control of brown rot.

FIG. 3.—A peach twig showing blossom blight, twig cankers, and killing of the tip, all caused by the brown-rot fungus

Development and rapid growth of the fungus is favored by moderate temperatures (70°–80° F.) and cloudy, rainy, or otherwise humid weather. The watery fruits of a rainy season are more susceptible to its attacks than the more solid fruits of the drier seasons. Fruits of trees receiving excessively heavy applications of nitrogenous fertilizers are considered more susceptible than those of trees receiving only moderate fertilization.

Although all the varieties of the peach are more or less susceptible to brown rot, those commonly met with on the markets belong to the less susceptible class. They have taken the places of many of the older and often better-flavored varieties, partly because they do not so readily succumb to brown rot in the orchard, in transit, and on the market. Because of differences in ripening seasons, it is impossible to classify varieties as to their relative susceptibility, since in the same season the conditions at the time of ripening of one variety may be very favorable to brown rot and at that of another variety very unfavorable. It is, however, well known that such varieties as Champion and Triumph are much more susceptible than Carman, Hiley, Belle, Elberta, Hale, and other commercial varieties of the present time.

It is a common experience that peaches grown on very rich land or on trees that have been overfertilized and overstimulated with nitrogen, either in the form of stable manure or other organic material or in the form of nitrate of soda, are abnormally subject to brown rot. It is considered good practice to prune the tree to an open head and to thin the branches as much as practicable to allow sunlight and air to penetrate the tree.

SCAB

In most of the sections of the eastern United States in which peaches are grown, scab, also known as black spot or freckle, is a serious disease. In commercial orchards it is not feared so much

as formerly, for the reason that it can be easily and successfully controlled by spraying or dusting. Except in the driest regions, scab probably occurs wherever peaches are grown throughout the world. It is favored by moist weather and moderate temperatures during the growing season. It is more liable to be serious in orchards having low, moist situations than in those having good air drainage.

Scab is a disease caused by the fungus *Cladosporium carpophilum* Thüm. It occurs on other stone fruits, such as the plum and the cherry, as well as on the peach, but it is of little importance except on the peach.

It occurs on the fruit, twigs, and leaves of the peach, but causes little damage to either twigs or leaves. It is, however, carried over from season to season principally in the tiny cankers on young twigs.

On the fruit, usually about the stem end, small circular spots one-sixteenth to one-eighth of an inch in diameter are formed. (Fig. 6.) At first these spots are rather faintly greenish and rather poorly defined. Later they become olivaceous to black with well-defined borders. Frequently the spots are so numerous that they run together, forming a large black scablike covering over as much as one-half the surface of the fruit. The name "freckle" appropriately describes typical spots which have not run together. (Fig. 6.) The scabby area frequently splits open, leaving a place for the entrance of brown-rot spores. Peaches with many infections of scab not only crack open, sometimes as far as the pit, but are usually much reduced in size and fail to fill out to the desired plumpness.

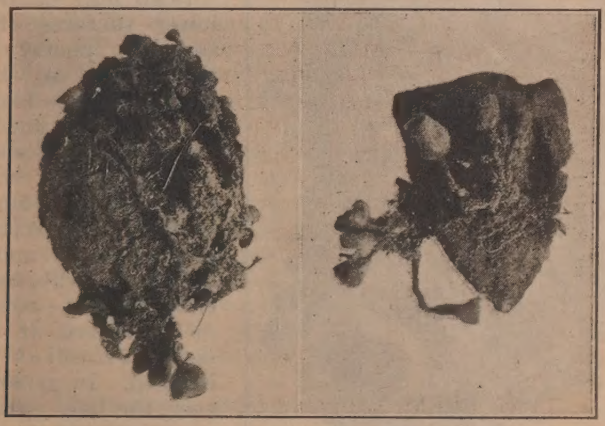

FIG. 4.—Mummied peaches producing the goblet-shaped fruiting bodies (apothecia) of the brown-rot fungus

In extreme cases the fruit may be so small and misshapen as to be worthless. The infections, being nearly always about the stem of the fruit, frequently cause the fruit to drop prematurely by killing the tissues about the point of attachment of the stem. The killing of these tissues, resulting in the loosening of the stem, is probably responsible for cutting off the supply of water and nutrients, thus resulting in the small size, lack of plumpness, and inferior flavor

of badly scabbed peaches. Spores formed in the diseased areas are capable of causing new spots on the same peach and on other peaches.

On the tender green twigs of the current season the disease appears as small, brown, oval spots or cankers, often with purplish borders. These tiny cankers, seldom more than one-eighth of an inch long, extend only slightly beneath the surface and accordingly cause little injury. They are of importance in that they serve to keep the fungus alive during the winter and thus produce during the following spring the spores which infect the new crop of fruit. During their second year the cankers begin to disappear and cease to be of importance.

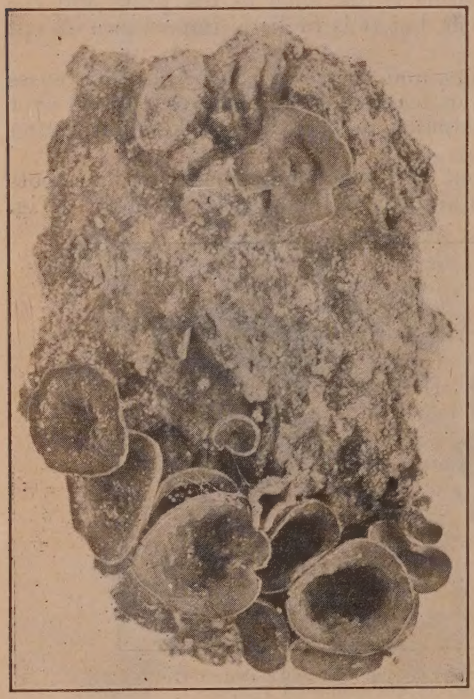

FIG. 5.—Mummied peach with goblet-shaped fruiting bodies (apothecia) of the brown-rot fungus. (Enlarged about 3 diameters)

Scab may occur on the lower surfaces of leaves, forming poorly defined, light-green to brownish patches on the blade, midrib, and stem, but it causes no injury of consequence.

As compared with most seedlings, the named varieties of commercial importance show a marked resistance to scab, but differences in the susceptibility or resistance of commercial varieties are not marked. In general, however, the later varieties are more subject to the disease, presumably because they are subjected to a longer exposure. Heath, Salwey, and Bilyeu are considered more susceptible than Elberta, and the latter is considered more susceptible than Carman, Hiley, or Belle.

PREVENTIVE MEASURES

REMOVING SOURCES OF INFECTION

It might be supposed that the removal of rotted fruits, cankers, and dead twigs from the orchard would prevent the occurrence of brown rot during the following year. Although this procedure is an aid in controlling the disease, it can not be relied upon as the only means of control, because (1) it is not possible to remove all the sources of infection, and (2) the spores may be blown into the orchard from outside sources.

Cleaning up, however, does materially reduce the sources of infection and probably is of great value in preventing blossom blight,

which is generally caused by spores from mummies. As has been pointed out, the blighted blossoms and ensuing cankers are important in carrying the disease over to the ripening fruit; therefore the prevention of blossom blight not only saves the blossoms but reduces the sources of later infection as well.

Probably the best time for removing the rotted fruits from the tree is at or directly after picking time, since at that time they have not shrunk in size so much as to be easily missed. At that time, too, the fungus frequently has not grown down the stems of the fruits and infected the twigs. However, they may be removed at any time before the following spring. Mummied fruits on the ground may be gathered up or plowed under. The latter method is probably the better one, since the half-buried mummies, which produce the goblet-shaped fruiting bodies most abundantly, are easily missed in gathering, and they are effectively disposed of by plowing. The completely buried mummies are rapidly disintegrated by the action of microorganisms.

The cankers and dead twigs appear to be unimportant as sources of infection, except perhaps in the humid regions close to the Atlantic coast. The removal of cankers is not practicable, and the removal of dead twigs should be incidental to the usual pruning operations.

FIG. 6.—Scab spots on peach

Although the removal of mummied fruits helps to control brown rot, it is of no importance in the control of scab, and the pruning out of twigs infected with scab is neither practicable nor necessary.

THINNING THE FRUITS

Thinning the fruits of heavily laden trees prevents the fruits from coming into contact with one another. If one of two peaches which touch each other rots, the other is almost certain to do so, the rot starting at the point of contact. Fruits which are close together, and especially those in contact with one another, can be covered with sprays or dust only with the greatest difficulty.

SPRAYING AND DUSTING

The principal method of controlling brown rot and scab is the application of sprays or dusts to the trees at certain times during the growing season. In seasons favorable to the development of brown rot and scab, thorough applications of the correct spray or dust, made at the right times, often mean the difference between a crop of clean fruit and no crop at all. In addition, the sprayed or dusted fruit is less subject to brown rot after picking, in transit, and on the market.

Previous to 1907 Bordeaux mixture was used to some extent as a spray for peaches, but it was so injurious that it can not be recommended. In 1907 W. M. Scott, of the United States Department of Agriculture, discovered that a mixture of sulphur, lime, and water, since known as self-boiled lime-sulphur, could be used on peach trees, either alone or in combination with arsenate of lead, with little risk of injury and with excellent results in the control of brown rot and scab. This mixture and similar ones are now in general use as fungicides for the control of these diseases.

Spraying should be done carefully with fine nozzles and with a pressure of at least 200 pounds. The spray should be shot through the tree from two opposite sides in order to cover the entire surface of the fruits. Care should be taken not to overspray, especially when arsenate of lead is an ingredient of the spray, as the leaves, fruit, and young twigs are easily injured by an excess of this material. In all applications the spray should be in the form of a fine mist. Such a spray covers well, decreases the risk of injury, and is desirable in the last application to prevent the formation of splotches which keep the fruit from coloring properly and may leave undesirable residues on the picked fruit. The copper sprays, such as Bordeaux mixture, and certain others which contain sulphur in solution, such as lime-sulphur solution, when used on peach trees during the growing season are apt to cause severe injury. After the spraying apparatus has been used for the application of self-boiled lime-sulphur or any of its substitutes it should be thoroughly cleansed, as all these mixtures, on drying, set almost as hard as cement. The quantity of spray fluid required to cover a peach tree ranges from about half a gallon to 4 gallons, depending on the size of the tree and the apparatus used. The average is probably somewhat less than 2 gallons.

With the advent of finely ground sulphur nearly 15 years ago, dusting with sulphur, a practice which had formerly been ineffective on account of the coarseness of the grains of sulphur, again came into use. It was found that the finely divided sulphur could be mixed with finely powdered arsenate of lead and hydrated lime to form a combined fungicide and insecticide. Scab is controlled at least as well with dust as with the liquid spray and in many cases more completely. It is probable that in very moist seasons requiring a maximum of effectiveness spraying would be somewhat superior to dusting for the control of brown rot. On the other hand, applications of dust can be made later in the season than sprays without much risk of preventing the fruit from coloring properly or of leaving undesirable residues. Dust, being more easily and more quickly applied, is more saving of labor. It is less liable than the sprays to cause injury.

When using dust it is essential to proceed along each row of trees, dusting the near side of each tree. It is practically impossible to obtain satisfactory results by dusting across the spaces between the rows. The quantity of dust required to cover a peach tree of average size is about one-fourth pound.

Whether spray or dust is used, growers in all sections where brown rot and scab occur should make the applications according to schedule. They should not lessen their efforts during a season following one in which the diseases have not been serious.

SPRAYING AND DUSTING SCHEDULES

For the control of brown rot, scab, and curculio[3] in the eastern half of the United States, except the humid regions of the Southeast including Georgia and the Gulf States, the following schedule is recommended.

FIRST APPLICATION

When calyces or "shucks" are shedding, which is usually about 10 days after the falling of the petals—

Spray: Powdered arsenate of lead, 1 pound (or 2 pounds of the paste) and the milk of lime from 3 pounds of stone lime or 4 pounds of hydrated lime with water sufficient to make 50 gallons; or

Dust: (1) Hydrated lime 95 per cent, arsenate of lead 5 per cent; or (2) sulphur 80 per cent, arsenate of lead 5 per cent, hydrated lime 15 per cent.

SECOND APPLICATION

Two weeks after the first application, or about four weeks after the petals have fallen—

Spray: Self-boiled lime-sulphur 8–8–50 (or substitute), to each 50 gallons of which 1 pound of powdered arsenate of lead (or 2 pounds of the paste) is added; or

Dust: Sulphur 80 per cent, arsenate of lead 5 per cent, hydrated lime 15 per cent.

THIRD APPLICATION

One month before each variety is expected to ripen—

Spray: Self-boiled lime-sulphur 8–8–50 (or substitute) without the addition of arsenate of lead; or

Dust: (1) Sulphur 80 per cent, hydrated lime 20 per cent; or (2) sulphur 80 per cent, arsenate of lead 5 per cent, hydrated lime 15 per cent.

This schedule is for early and midseason varieties. For varieties later than Elberta an additional application of self-boiled lime-sulphur or one of its substitutes should be made about four weeks after the second application. The first application is primarily for the control of the curculio, the second is primarily for the control of scab and curculio, and the third is primarily for the control of brown rot. The additional application on late varieties is primarily for the control of scab. Some growers prefer to use in the first application self-boiled lime-sulphur (or a substitute) or a dust containing sulphur. There is no objection to such a procedure, but it is considered unnecessary.

For the southeastern United States, including Georgia and the Gulf States, the following schedule is recommended.

FIRST APPLICATION

Immediately after 75 per cent of the petals have fallen—

Spray: Powdered arsenate of lead 1 pound (or 2 pounds of the paste) and the milk of lime from 3 pounds of stone lime or 4 pounds of hydrated lime with water sufficient to make 50 gallons; or

Dust: (1) Hydrated lime 95 per cent, arsenate of lead 5 per cent; or (2) sulphur 80 per cent, arsenate of lead 5 per cent, hydrated lime 15 per cent.

SECOND APPLICATION

When calyces or "shucks" are shedding, which is usually about 10 days after the falling of the petals—

Spray: Same as for first application; or

Dust: Same as for first application.

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[3] Directions for the use of arsenate of lead in the control of the curculio were furnished by the Bureau of Entomology, U. S. Department of Agriculture.

THIRD APPLICATION

Two weeks after the second application, or about four weeks after the first application—

Spray: Self-boiled lime-sulphur 8–8–50 (or substitute); or

Dust: (1) Sulphur 80 per cent, hydrated lime 20 per cent; or (2) sulphur 80 per cent, arsenate of lead 5 per cent, hydrated lime 15 per cent.

FOURTH APPLICATION

One month before each variety is expected to ripen—

Spray: Self-boiled lime-sulphur 8–8–50 (or substitute), to each 50 gallons of which 1 pound of powdered arsenate of lead (or 2 pounds of the paste) is added; or

Dust: Sulphur 80 per cent, arsenate of lead 5 per cent, hydrated lime 15 per cent.

This schedule is for early and midseason varieties. For varieties later than Elberta an additional application of self-boiled lime-sulphur or one of its substitutes should be made about four weeks after the third application. The first and second applications are primarily for the control of curculio, the third is primarily for the control of scab, and the fourth is primarily for the control of curculio and brown rot. The additional application on late varieties is primarily for the control of scab. Some growers prefer to use in the first two applications self-boiled lime-sulphur (or a substitute) or a dust containing sulphur. There is no objection to such a procedure, but it is considered unnecessary.

ADDITIONAL APPLICATIONS

FOR CONTROL OF BROWN ROT ON THE FRUIT

An additional application of dust (sulphur 100 per cent, or preferably sulphur 80 per cent, and hydrated lime 20 per cent) may be made within a week of the time the fruit is expected to ripen. This application may be of use in preventing brown rot on the fruit both on the tree and after it is picked, especially during a wet season. The dusting should be very lightly done in order to avoid residues on the picked fruit. If only a light application is made the weather and the ordinary handling of the fruit should remove all noticeable traces of the dust. In any event no fruit should be offered for sale which shows noticeable residues of dust or spray, no matter how harmless the residues may be.

The regular schedule, properly applied, should not result in any residues of arsenic in injurious quantities. It should be noted that the additional applications suggested are of the harmless chemicals, sulphur and lime, without the arsenic. In view of the keen attention now being given to spray residues remaining on fruit on the market, the grower is cautioned not to use arsenic in any of these later applications. It is not permissible to make applications of arsenical sprays late enough to allow even invisible residues of arsenic to remain until picking time nor visible residues of the noninjurious materials. Rains and weathering are counted on to remove objectionable spray residues on peaches grown in the humid eastern United States, where brown rot necessitates the foregoing spraying and dusting schedules.

FOR CONTROL OF BLOSSOM BLIGHT

The writers have not been very successful in controlling blossom blight in the South by applying spray at the time the blossoms are showing pink (just before they open). The Maryland Agricultural Experiment Station has reported excellent results in Maryland orchards from an application of self-boiled lime-sulphur or of the sulphur, hydrated-lime, and casein mixture (dry mix) made at that time.

SPRAY MIXTURES

SELF-BOILED LIME-SULPHUR MIXTURE

The mixture of milk of lime, sulphur, and water known as self-boiled lime-sulphur, perfected by W. M. Scott, of the Bureau of Plant Industry, 20 years ago, was the first fungicide which could be sprayed on the peach without risk of severe injury and could at the same time control brown rot and scab. For the control of brown rot and scab of the peach it has not been surpassed by the newer sulphur sprays designed as substitutes for it, and it is less liable to cause injury than any of the substitutes yet developed.

The formula for the standard mixture is as follows:

Sulphur (flowers, flour, or "commercial ground")	pounds	8
Stone lime	do	8
Water	gallons	50

The preparation of the mixture is facilitated by making it up in fairly large quantities, at least enough for 200 gallons of spray, but it can be made up in very small quantities.

The lime should be placed in a barrel and enough water added nearly to cover it. If the lime is found not to slake readily in cold water, hot water should be used. With sluggish lime it is also well to cover the barrel with sacks or heavy cloth of some kind to prevent the escape of the heat. As soon as the slaking of the lime is well under way, the sulphur, first passed through a sieve to break up the lumps, should be added. If the sulphur is stirred into a small quantity of water before it is added it will be more evenly distributed and more easily worked into the lime. After the addition of the sulphur the mixture should be constantly stirred and more water added from time to time as needed to form at first a thick and then gradually a thin paste. The lime should supply enough heat to boil the mixture several minutes. As soon as slaking has ceased, water should be added to cool the mixture and prevent further cooking. The mixture is then ready to be strained into the spray tank, diluted, and applied.

The stage at which water should be added to cool the mixture varies with different limes. Some limes slake so slowly that it is difficult to obtain sufficient heat from them, while others become intensely hot on slaking and cause the mixture to boil violently. Care should be taken, especially with rapidly-slaking limes, not to allow the boiling to last too long. If the mixture is allowed to remain hot for 15 or 20 minutes after slaking is completed, some of the sulphur combines with some of the lime to form sulphides which are injurious to peach foliage. The presence of these sulphides

is indicated by the appearance of reddish-brown streaks in the mixture. When these begin to appear it is a sign that the mixture should be cooled at once. If rapidly-slaking lime is used, it is especially important to cool the mixture quickly by adding a few bucketfuls of water as soon as the lime has slaked. The final product is a uniform lemon-colored mixture of finely divided sulphur and lime, with only a very small percentage of the sulphur in solution. The mixture should be strained to take out the coarse particles of lime, but the sulphur should be carefully worked through the strainer. Good agitation of the spray after it is placed in the tank is essential to prevent settling.

SUBSTITUTES FOR THE SELF-BOILED LIME-SULPHUR MIXTURE

SULPHUR AND HYDRATED-LIME MIXTURE

The sulphur and hydrated-lime mixture, devised by G. C. Starcher, of the Virginia Agricultural Experiment Station, as a substitute for self-boiled lime-sulphur, is made by using hydrated lime in place of stone lime, the necessary heat being supplied by boiling water. The formula is as follows:

Sulphur (flowers, flour, or "commercial ground")	pounds	8
Hydrated lime (fresh)	do	8
Boiling water	gallons	8
Finally, cold water to make	do	50

The sulphur and the hydrated lime should be mixed together dry and then passed through a sieve. Place the dry mixture in a barrel or other suitable container and add the boiling water. Stir for five minutes and then add sufficient cold water to cool the mixture thoroughly. Run through a strainer into the tank previously filled with sufficient water to make the required quantity. Do not allow the boiling water to act for more than five minutes. The resulting spray fluid must be kept well agitated.

SULPHUR, HYDRATED-LIME, AND GLUE MIXTURE

The sulphur, hydrated-lime, and glue mixture is a substitute for self-boiled lime-sulphur in which the suspension of the sulphur and lime is effected through the presence of a colloidal substance, glue, which forms with sulphur and lime a mixture that takes water readily. The formula is as follows:

Sulphur (finely ground flour or flowers)	pounds	8
Hydrated lime (fresh)	do	8
Ground glue	ounces	2
Water to make	gallons	50

The glue (common ground glue obtainable at drug stores) should be dissolved in a small quantity of hot water and then diluted with sufficient water to make about 4 gallons. Mix the sulphur—preferably the so-called dusting sulphur—and the lime together thoroughly and pass the mixture through a sieve. Place the mixture in a barrel or other suitable container and slowly add the glue solution, stirring the mixture vigorously. After the ingredients have been well mixed, add water slowly, with continuous stirring, until a mixture of the consistency of thin paint is obtained. Strain this into the spray

tank, which should contain sufficient water to make the required quantity, and keep the mixture well agitated. If arsenate of lead is not to be used with the mixture, the quantity of lime may be reduced one-half if desired.

SULPHUR, HYDRATED-LIME, AND CASEIN MIXTURE

The sulphur, hydrated-lime, and casein mixture is commonly known as "dry mix" and is a substitute for the self-boiled lime-sulphur. It is similar to the sulphur, hydrated-lime, and glue mixture. The hydrated lime takes the place of the stone lime used in the self-boiled lime-sulphur, and the casein takes the place of heat in bringing about a suspension of the ingredients in water. The following formula is recommended:

Sulphur (finely ground flour or flowers)	pounds	8
Hydrated lime (fresh)	do	8
Casein-lime mixture	do	½
or		
Casein	do	¼
Water to make	gallons	50

The finely divided "dusting sulphur" should be used. Casein-lime may be purchased ready prepared, under various trade names. The lime and the sulphur should be passed through a sieve to remove any lumps. All three ingredients should then be thoroughly mixed together dry. Water should be added slowly with continuous stirring until the mixture is of the consistency of thin paint. It should then be added to the required quantity of water in the spray tank.

The quantity of lime may be reduced one-half, if desired, when arsenate of lead is not added to the spray. One would then be following the formula of A. J. Farley, of the New Jersey Agricultural Experiment Station. Most of the ready-mixed sulphur-hydrated lime-casein mixtures which are sold on the market under various trade names are made up according to Farley's formula. When such mixtures are used with arsenate of lead, about 4 pounds of hydrated lime should be added to each 50 gallons of spray to lessen the risk of injury.

SULPHUR, HYDRATED-LIME, AND SKIM-MILK MIXTURE

R. H. Robinson, of the Oregon Agricultural Experiment Station, has suggested a mixture made up as follows:

Sulphur (superfine flour)	pounds	8
Hydrated lime	pounds	4
Skim milk	quarts	2

The sulphur should be the so-called dusting sulphur. If skim milk is not available, whole milk may be used. Milk only slightly sour may be used. Mix the sulphur and the lime. Add 2 quarts of water to the 2 quarts of milk and stir it into the sulphur and lime. Add more water as the paste becomes thick. Finally, add several gallons and pass the fluid through a strainer into the spray tank. Add the required quantity of water, or, better still, have it already in the tank.

This mixture has not been tried by the writers, and accordingly they are unable to judge its merits. When used with arsenate of lead,

the mixture would probably be less liable to cause injury if the quantity of lime in the foregoing formula were doubled.

COMMERCIAL SUBSTITUTES FOR SELF-BOILED LIME-SULPHUR

Numerous substitutes for self-boiled lime-sulphur are on the market. Some of them are composed principally of sulphur in colloidal form, and others are pastes or powders containing finely divided sulphur, lime, and a colloidal substance such as glue or casein to make the mixture take water. When used with arsenate of lead, most of them require the addition of at least 4 pounds of hydrated lime to each 50 gallons of spray in order to lessen the risk of injury. In buying commercial substitutes for self-boiled lime-sulphur, growers should be sure that they are not getting substitutes for the better known and more widely used lime-sulphur solution, which is recommended for use on the peach only during the dormant season. When mixed with water the latter forms a clear reddish brown solution, the former a lemon-colored or milky fluid.

ARSENATE OF LEAD

Arsenate of lead in powdered or paste form can be obtained from dealers in spray supplies. At the present time the powdered form is more generally used than the paste. Arsenate of lead should be the last ingredient added to the spray mixture and should be thoroughly mixed with sufficient water to form a thin paste before it is poured in.

DUSTS

For use on peaches the following mixtures of dust are recommended:

(1) Sulphur 80 per cent, arsenate of lead 5 per cent, hydrated lime 15 per cent.
(2) Sulphur 80 per cent, hydrated lime 20 per cent; or sulphur 100 per cent.
(3) Hydrated lime 95 per cent, arsenate of lead 5 per cent.

Formula No. 1 should be used in applications requiring both sulphur and arsenate of lead. If desired, it may be used in all applications made not later than one month before the fruit is expected to ripen.

Formula No. 2 is for the late applications from which arsenate of lead is omitted.

Formula No. 3 is for the early applications in which the spraying schedule does not call for sulphur.

The materials should be very finely divided and especially made for dusting purposes. They may be mixed at home or if desired may be bought ready mixed. Small quantities may be mixed with a shovel or a hoe, but care should be taken to make the mixture uniform. There are a number of homemade contrivances similar to cement mixers which appear to mix the ingredients effectively. For handling large quantities very efficient mixing machines may be purchased.

U. S. GOVERNMENT PRINTING OFFICE : 1927